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GB 2299062 A EP 0581432 A1 US 5575501 A
US 4741408 A

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(54) Abstract Title
Energy absorbing type electric power steering system

(57) An energy absorbing type electric power steering system comprises, a first steering shaft (11) having a steering wheel (25) attached to its rear end and power assist mechanism (19) attached to its forward end, an output portion (17) of the first shaft extending from the power assist mechanism, and a second shaft (21) joined to the output portion by a universal joint (23). The output portion (17) has collapsible means (see figure 3) to allow a reduction in length upon an impact. The second steering shaft (21) may also have impact absorbing means (see figure 2). The two impact absorbing means located to the forward side of the power assist mechanism are intended to allow a reduction in length of the steering mechanism without resulting in the power assist mechanism becoming unattached from the vehicle body structure. The energy absorbing means may include a serrated portion along the steering shaft having an incomplete serration (see figures 4 and 5), a ball bearing coming into contact with the crest of a serration (see figures 8 and 9), or part of the steering shaft being of an elliptical formation (see figure 10).

FIG. 1

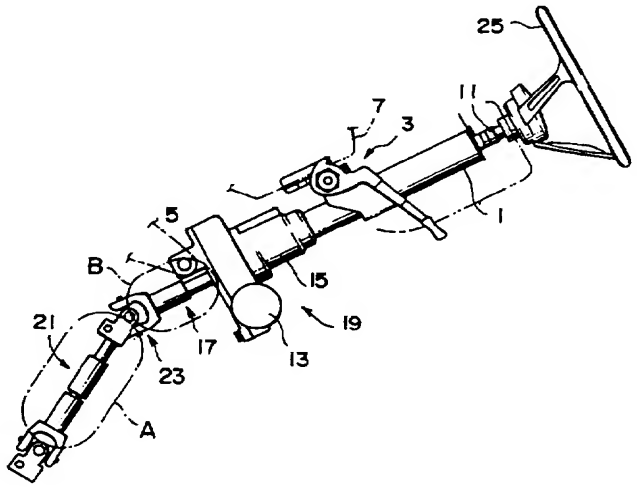

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FIG. 1

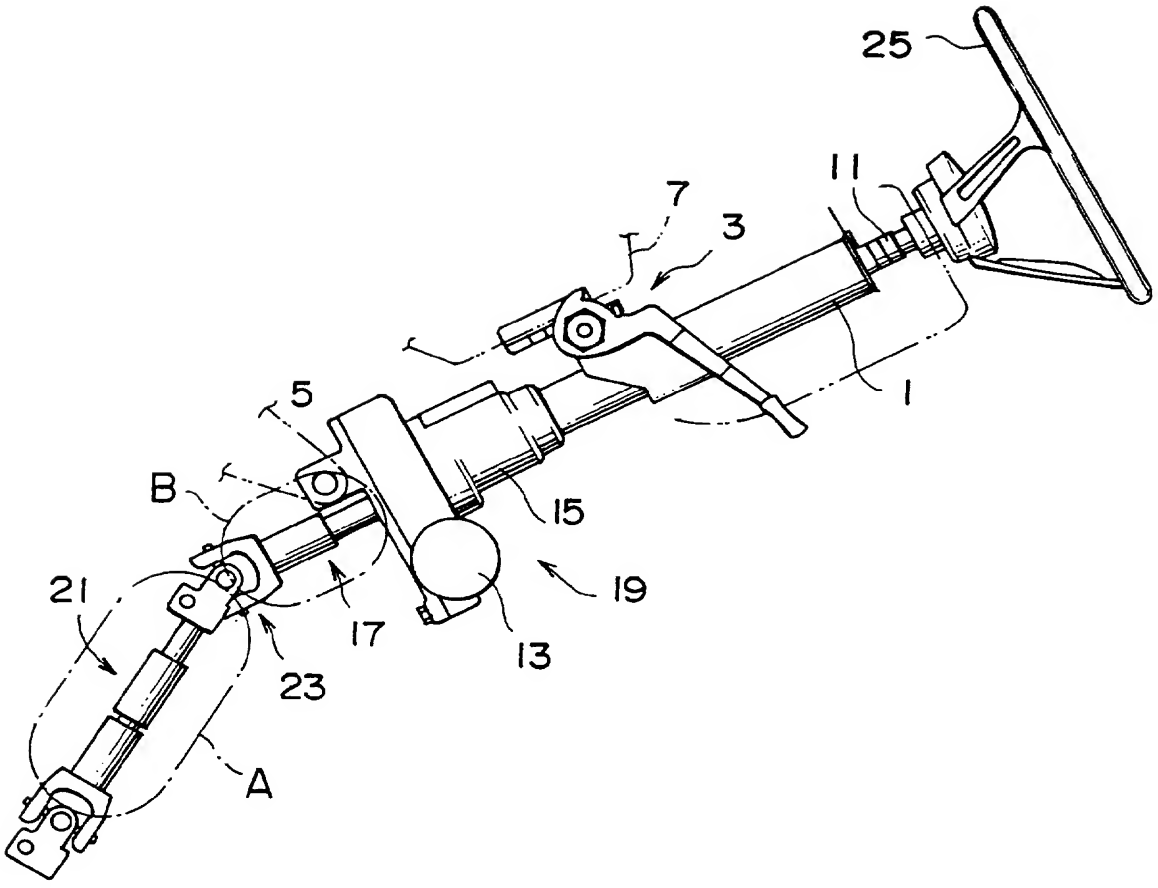


FIG. 2

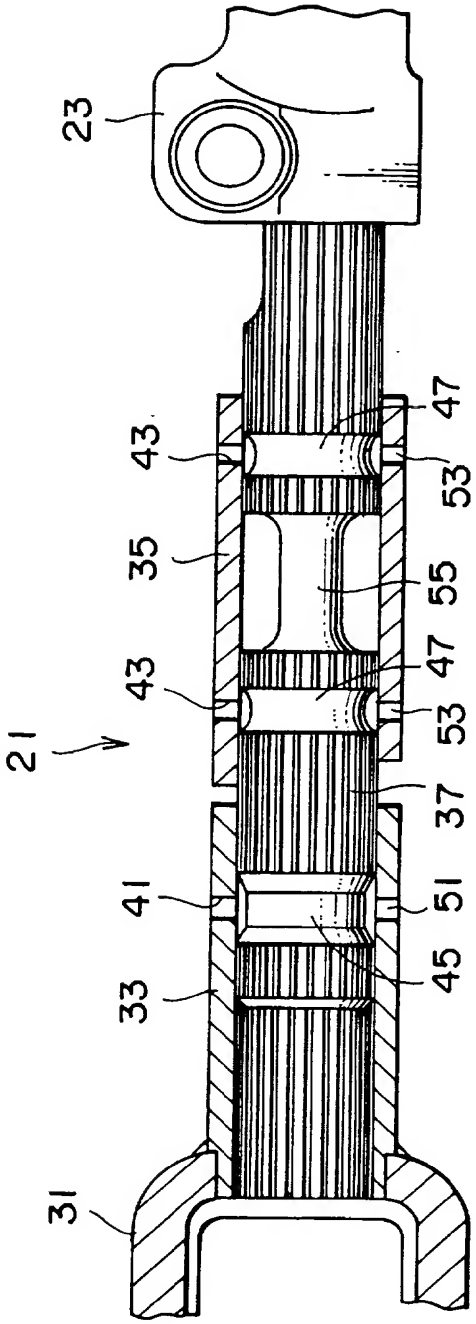


FIG. 3

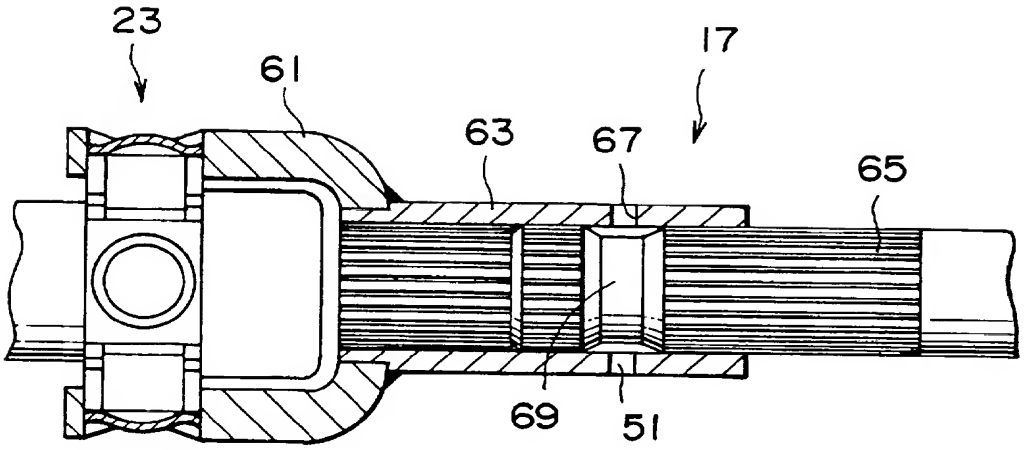


FIG. 4

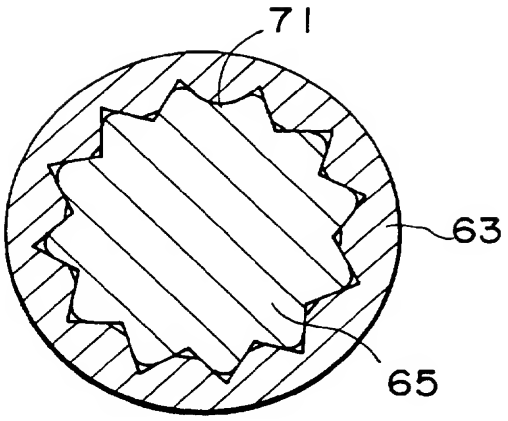


FIG. 5

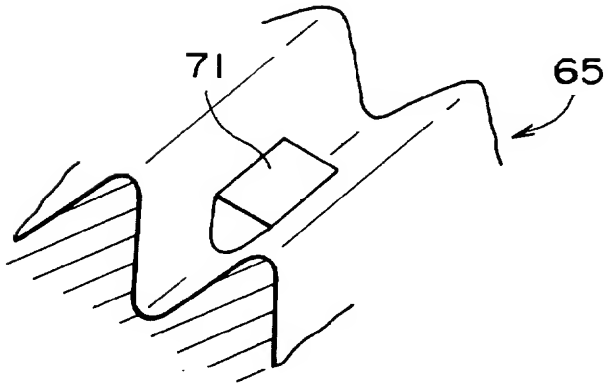


FIG. 6

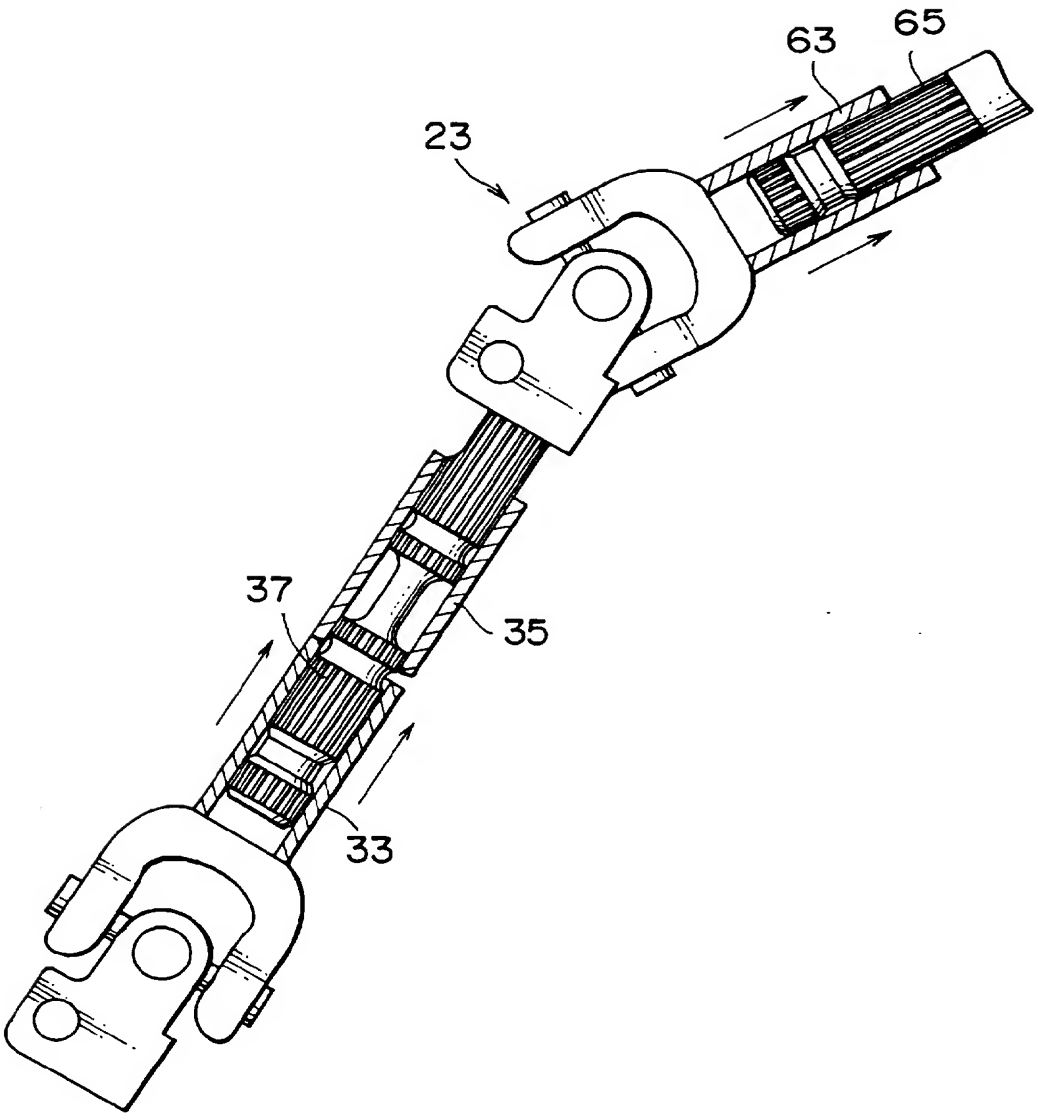


FIG. 7

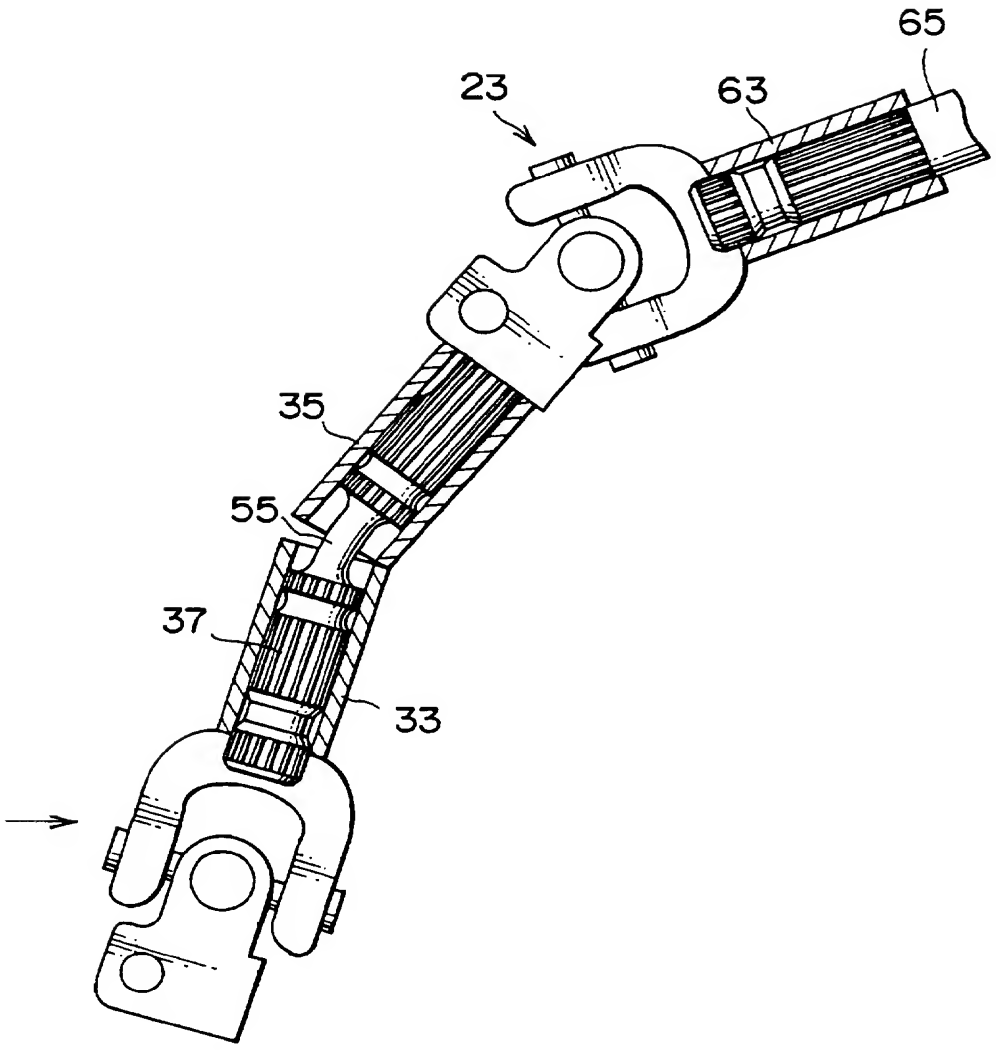


FIG. 8

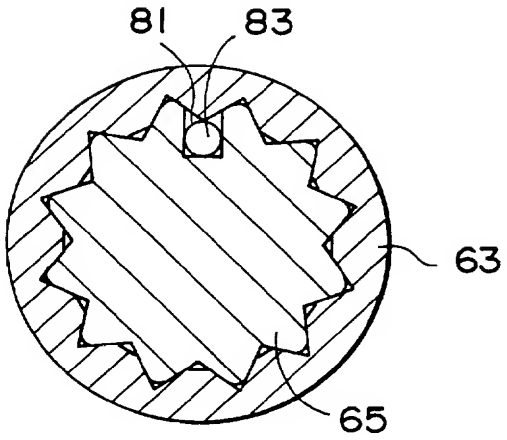


FIG. 9

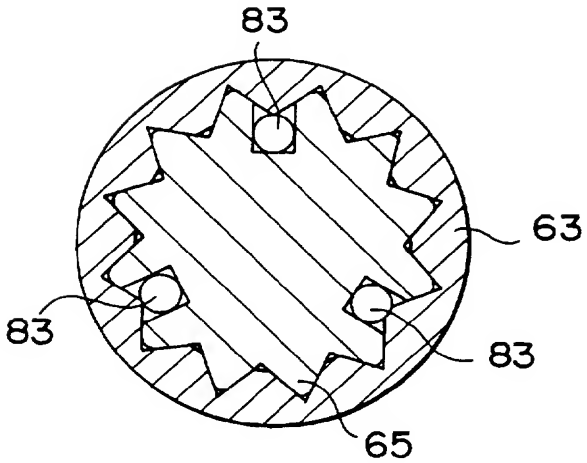
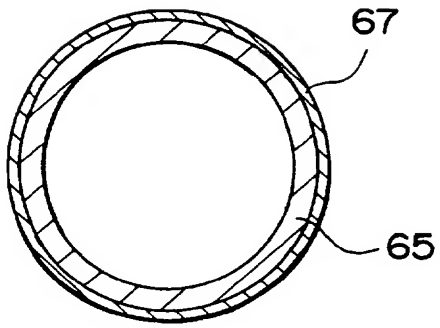


FIG. 10



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SHOCK ABSORBING TYPE ELECTRIC POWER STEERING SYSTEM

This application claims the benefit of Japanese Patent Application No. 10-332931 which is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates generally to a shock absorbing type electric power steering system and more particularly to a technology of increasing a quantity of an impact energy absorption when a primary collision happens.

Related Background Art

When a car collides with other car or a structure etc, a cross member etc for holding a steering gear is thrust back, with the result that a steering shaft might protrude into a car room. Such being the case, in automobiles manufactured over the recent years, as disclosed in Japanese Patent Application Laid-Open No. 10-76958, a shock absorbing type steering system has been widely adopted to prevent such a situation. What is typical of the shock absorbing type steering system is that the steering shaft collapses while absorbing an impact energy and is separated into an outer shaft and an inner shaft, and these two lengths of shafts slidably mesh with each other through their serration etc. Normally, a shock absorbing mechanism resisting the

collapse is provided between the outer shaft and the inner shaft. An energy absorbing member, with the steering shaft collapsing when an axial load over a predetermined value acts thereon, absorbs the impact energy.

On the other hand, as an automobile steering system, an electric power steering system (which is hereinafter be abbreviated to EPS) with an electric motor serving as a power source has been developed in recent years. The EPS is classified into a column assist type and a pinion assist type depending on a position to which the electric motor is attached, and steering shaft and the steering gear pinion etc are assisted corresponding to the types. In the column assist type EPS, as disclosed in Japanese Patent Application Laid-Open Publication No. 10-76958, a deceleration gear box fixed to a car body structural member is integrated with a front side end of the steering column, and the electric motor is fitted to the deceleration gear box. Rotations of the electric motor are decelerated by a worm deceleration mechanism encased in the deceleration gear box, and thereafter transferred to an output shaft constituting a part of the steering shaft.

In the case of adopting the column assists type EPS as the shock absorbing type steering system, for the reason which will hereinafter be elucidated, it might happen that a quantity of displacement due to the impact caused by the primary collision is not sufficiently

absorbed.

Normally, the car-room side steering shaft is separated into a first steering shaft (a steering upper shaft) to which a steering wheel is attached, and an second steering shaft (a steering intermediate or lower shaft) connected via a universal joint to the output shaft. The impact energy absorbing mechanism coping with a secondary collision is, however, provided on the side of the first steering shaft, and the deceleration gear box is positioned on the front side. Consequently, an entire length of the second steering shaft becomes smaller than the normal shaft in many cases. Therefore, the impact absorbing mechanism of the second steering shaft can not absorb all the displacement caused due to a deformation of the car body structural member by the thrust-back of the steering gear upon the primary collision in order to maintain the displacement absorption quantity on the secondary collision side, with the result that the deceleration gear box comes off the car body structural member. Then, the first steering shaft is thrust back on the driver's side.

SUMMARY OF THE INVENTION

It is a primary object of the present invention, which was devised under such circumstances, to provide a shock absorbing type electric power steering system contrived to increase a displacement absorption quantity due to an impact upon a primary collision.

To accomplish the above object, according to one aspect of the present invention, a shock absorbing type electric power steering system comprises a deceleration gear box attached to a front side end of a steering column, fixed to a car body structural member, and used for holding a deceleration gear mechanism and an electric motor, an output shaft rotatably held in the deceleration gear box and constituting a part of the steering shaft, and a second steering shaft joined via a universal joint to the output shaft, and including an impact absorbing mechanism in a part thereof, wherein a mechanism of which an entire length is reducible upon an impact is provided between the output shaft and the universal joint.

According to the present invention, a displacement caused by the impact upon a primary collision is absorbed by the impact absorbing mechanism provided between the output shaft and the universal joint as well as by the impact energy absorbing mechanism provided in the second steering shaft, whereby a deformation of the car body structural member and a come-off of the deceleration gear box are hard to occur.

BFIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate presently preferred embodiment of the invention, and together with the general description given above and the detailed description of the preferred embodiment

given below, serve to explain the principle of the invention, in which:

FIG. 1 is a side view showing a shock absorbing type electric power steering system according to the present invention;

FIG. 2 is a sectional view showing an A-portion in enlargement in FIG. 1;

FIG. 3 is a sectional view showing a B-portion in enlargement in FIG. 1;

FIG. 4 is a principal vertical sectional view of a fitting portion between an inner shaft and an outer tube;

FIG. 5 is a perspective view showing an incomplete serrate portion;

FIG. 6 is an explanatory diagram showing an operation in an embodiment;

FIG. 7 is an explanatory diagram showing the operation in the embodiment;

FIG. 8 is a sectional view showing a first modified example of an impact energy absorbing mechanism;

FIG. 9 is a sectional view showing a second modified example of the impact energy absorbing mechanism; and

FIG. 10 is a sectional view showing a third modified example of the impact energy absorbing mechanism.

DESCRIPTION OF THE PREFERRED EMBODIMENT

An embodiment of the present invention will hereinafter be described with reference to the

accompanying drawings.

FIG. 1 is a side view showing a shock absorbing type electric power steering system according to the present invention on the side of a car room. A steering column designated by the numeral 1 in FIG. 1 is fixed to cross members 7, 9 classified as car body structural members through a tilt mechanism 3 and a pivot pin 5. A steering upper shaft 11 defined as a first steering shaft is rotatably supported inside the steering column 1, and, at the same time, a power assist mechanism 19 constructed of the electric motor 13, the deceleration gear box 15, the output shaft 17, is integrated with the front side end of the steering column 1.

In this embodiment, the deceleration gear box 15 is a casting composed of an aluminum alloy, and the pivot pin 5 is rotatably held at an upper part of the deceleration gear box 15. Referring to FIG. 1, a steering intermediate shaft 21 categorized as a second steering shaft is joined to a front side end of an output shaft 17 via a universal joint 23.

A steering wheel 25 is attached to a rear side end of the steering upper shaft 11. When the driver rotates the steering wheel 25, a rotating force thereof is enhanced by the power assist mechanism 19 and thereafter transferred via the output shaft 17 to the steering intermediate shaft 21 and further to the steering gear via the unillustrated steering lower shaft.

FIG. 2 is a sectional view showing an A-portion in enlargement in FIG. 1. As shown in FIG. 2, the steering intermediate shaft 21 is constructed of a first outer tube 33 of which a front side end has a joint yoke 31 integrally welded thereto, a second outer tube 35 disposed in rear of the first outer tube 33, and an inner shaft 37 inserted in interposition between those two outer tubes 33, 35. The two outer tubes 33, 35 and the inner shaft 37 mesh with each other through their serration. Then, through-holes 41, 43 formed in the two outer tubes 33, 35 are engaged with annular grooves 45, 47 formed in the inner shaft 37 by use of resin pins 51, 53. Referring to FIG. 2, the numeral 55 represents a small-diameter fragile portion formed extending from the inner shaft 37.

FIG. 3 is a sectional view showing a B-portion in enlargement in FIG. 1. On the other hand, as illustrated in FIG. 3, the output shaft 17 is also constructed of an outer tube 63 of which a front side end has a joint yoke 61 of the universal joint 23 integrally welded thereto, and an inner shaft 65 inserted into the outer tube 63. The outer tube 63 and the inner shaft 65 mesh with each other through their serration, and a through-hole 67 formed in the outer tube 63 is engaged with an annular groove 69 formed in the inner shaft 65 by use of the resin pin 51.

Further, in the case of providing the impact

absorbing mechanism in FIG. 3, in the output shaft 17, as shown in a principal sectional view in FIG. 4, an incomplete serrate portion 71 is formed as an impact absorbing mechanism partially in the inner shaft 65. The incomplete serrate portion 71 is, as shown in FIG. 5, formed in such a way that a part of root is incompletely cut and remained, and becomes a large resistance when the inner shaft 65 slides on within the outer tube 63. Note that front and rear ends of the incomplete serrate portion 71 are formed with slopes, thereby preventing galling with the serration of the outer tube 63 and an abrupt load fluctuation.

An operation in this embodiment will hereinafter be described.

When the cross members holding the steering gear are thrust back subsequently to the car collision, a large axial load acts on the steering intermediate shaft 21 through the unillustrated steering lower shaft. Thereupon, heads of the resin pins 51, 53 are cut off in the steering intermediate shaft 21, and, as shown in FIG. 6, the inner shaft 37 enters inside the first and second outer tubes 33, 35. The steering intermediate shaft 21 thereby collapses by a predetermined quantity, thereby absorbing a displacement caused by the impact.

On the other hand, the axial load acting upon the steering intermediate shaft 21 acts also on the output shaft 17 joined to the steering intermediate shaft 21.

Accordingly, the resin pin 51 is cut off in the output shaft 17, and, as shown in FIG. 6, the inner shaft 65 enters inwardly of the outer tube 63. The output shaft 17 thereby becomes collapsed by a predetermined quantity, thereby absorbing the impact. Further, if the energy absorbing mechanism is provided, the impact energy is absorbed by a slide resistance of the incomplete serrate portion 71.

Thus, in accordance with this embodiment, the impact energy is absorbed in the output shaft 17 as well as in the steering intermediate shaft 21, and hence the cross member 9 becomes by far harder to deform and the deceleration gear box 15 also becomes by far harder to come off than in the conventional system. Note that in this embodiment, if the impact energy is not completely absorbed by the steering intermediate shaft 21 and the output shaft 17, as shown in FIG. 7, the inner shaft 37 on the side of the steering intermediate shaft 21 is bent at the fragile portion 55, thereby preventing an excessive load from being applied to the deceleration gear box 15 and the cross member 9 as well. A bellows type may be adopted as a bending mechanism in other form. Further, even if not bent, a breaking-off mechanism also prevents the excessive load from being applied thereto.

FIGS. 8 - 10 respectively show three modified examples of the impact energy absorbing mechanism. A first modified example shown in FIG. 8 is that a recess

81 is formed in a part of the inner shaft 65, and a steel ball 83 is fitted into the recess 81 and is brought into a contact at a predetermined pressure with a crest of the serration of the outer tube 63. According to the first modified example, when the inner shaft 65 slides on within the outer tube 63, the crest of the serration of the outer tube 63 with which the steel ball coming into the pressure-contact, is plastically or elastically deformed, and the impact energy is absorbed by a resistance of the deformation thereof.

Further, a second modified example shown in FIG. 9 is that the steel balls 83 are provided in three positions at an interval of 120° . The absorption quantity of the impact energy can be adjusted easier than in the first modified example, and, in addition, an occurrence of a peak load can be restrained by shifting axial positions of the respective steel balls 83. On the other hand, a third modified example shown in FIG. 10 is that the outer tube 63 taking a complete round shape is fitted to the inner shaft (the inner tube) 65, and a part thereof is deformed in an elliptical configuration. Both of the outer and inner tubes are elastically or plastically deformed, thereby absorbing the impact energy. Note that the outer tube 63 and the inner shaft 65 may be formed as simple round tubes or may mesh with each other through the serration in the third modified example.

The specific embodiment discussed so far comes to an end of its explanation, however, the mode of the present invention is not limited to the embodiment described above. For example, the embodiment discussed above is that the present invention is applied to the shock absorbing type electric power steering system including the tilt mechanism, however, the present invention may be applied to what does not include the tilt mechanism. Further, the collapsible mechanism and the impact energy absorbing mechanism, which are provided in the steering intermediate shaft and the output shaft, may adopt a spline type and such type as to embed balls and so forth in addition to the serration type exemplified in the embodiment explained above. As for others, the specific construction of the steering system may be properly changed within the range of the present invention without departing from the sprit of the present invention.

As discussed above, the shock absorbing type electric power steering system according to the present invention has the deceleration gear box attached to the front side end of the steering column, fixed to the car body structural member and used for holding the deceleration gear mechanism and the electric motor, the output shaft rotatably held in the deceleration gear box and constituting a part of the steering shaft, and a second steering shaft joined via the universal joint to

the output shaft and provided with the impact absorbing mechanism in a part thereof. In the thus constructed electric power steering system, the impact energy absorbing mechanism is provided between the output shaft and the universal joint, and therefore the impact caused by the primary collision is absorbed by the impact absorbing mechanism provided between the output shaft and the universal joint as well as by the impact absorbing mechanism provided in the second steering shaft, whereby the deformation of the car body structural member and the come-off of the deceleration gear box become hard to occur.

Accordingly, in the cases where any influence is not exerted on the impact absorbing mechanism against the secondary collision, and where the absorbing mechanism of the present invention does not need to operate upon the primary collision, when the whole steering column moves upon the secondary collision, the impact can be absorbed in that position.

CLAIMS:

1. A shock absorbing type electric power steering system comprising:

a first steering shaft having its rear side end to which a steering wheel is fitted;

a steering column for inwardly rotatably supporting said first steering shaft;

a deceleration gear box attached to a front side end of said steering column, fixed to a car body structural member, and used for holding a deceleration gear mechanism and an electric motor;

an output shaft rotatably held in said deceleration gear box and constituting a part of said steering shaft; and

a second steering shaft joined via a universal joint to said output shaft, and including an impact absorbing mechanism in a part thereof,

wherein a mechanism of which an entire length is reducible upon an impact is provided between said output shaft and said universal joint.

2. Steering column apparatus comprising:

a rear steering shaft having an input end portion for connection to a steering wheel and an output end portion for connection to a fore steering shaft; an electric power steering assisting mechanism for providing steering power to the output portion; wherein the output portion is lengthwise collapsible to absorb an impact to the steering column apparatus.

3. A shock absorbing type electric power steering system or steering column apparatus substantially as hereinbefore described with reference to Figures 1 to 7; or Figures 1 to 7 as modified by Figure 8, 9 or 10.

The Patent Office

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Application No: GB 9927700.6
Claims searched: 1 and 2

Examiner: Peter Gardiner
Date of search: 14 March 2000

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): B7B: BSDA

Int Cl (Ed.7): B62D: 1/18, 1/19, 5/04

Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
Y	EP 0581432 A1	NSK LTD (see figure 4 and column 7 lines 3 to 5)	1
X,Y	US 4741408	GENERAL MOTORS (see figure 1 and column 2 line 54 to column 3 line 10)	X: 2 Y: 1
A	GB 2299062 A	NSK LTD (see whole document)	
A	US 5575501 A	NSK LTD (see whole document)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.